

# Wind Turbine Development

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## Helping develop a new generation of wind turbines for the worldwide markets of the next century

Some wind turbines are impressive, awe-inspiring pieces of hardware, standing 30 to 50 meters above the ground with blades turning in a diameter of 50 meters or more. Others fit into the landscape at just the right size for their specific application. Whatever their use, modern wind turbines incorporate the latest, high-tech mechanical and electrical equipment, and are made of components that have taken engineers years to research and develop.

Examples of the improvements in modern turbines are the use of improved electronic controls, redesigned airfoils, variable speed operation, and integrated drive trains. The integrated drive trains, for instance, weigh less, create an efficient load path from the rotor to the generator, and eliminate couplings between

the gearbox and generator that typically caused excessive downtime. Because of innovations such as these, turbine availabilities have increased from 60% in the early 1980s to 98% today, and the annual energy produced per installed capacity has increased ten-fold.

Some of the best commercial turbines made in this country have been developed through cost-shared projects between the U.S. Department of Energy (DOE) and the U.S. wind industry. These include the Z-40, the Z-46, the AWT-26, and the AOC 15/50.

The Z-40 and Z-46 are both utility-scale turbines produced by Zond Energy Systems, Inc. (a subsidiary of Enron Wind Energy Corporation, of Tehachapi, California). Currently, two U.S. utilities are using the Z-40, rated at 550 kilowatts (kW), in wind

### Highlights

- **Cost-shared projects with the U.S. Department of Energy and the wind industry have produced new, commercially available turbines that generate power at low costs.**
- **These new turbines are helping U.S. manufacturers compete for a growing worldwide wind energy market.**
- **Further turbine advances are expected to achieve wind energy costs as low as \$0.025 per kilowatt-hour (kWh), competitive with fossil-fueled generating technologies.**
- **Advanced wind turbine technologies will be instrumental for the United States and other countries in meeting their commitments to reduce greenhouse gases.**



NREL/PIX #05603

**The Zond  
Energy  
Systems, Inc.  
Z-40**



NREL/PIX #01497

**The Advanced Wind  
Turbines, Inc. AWT-26**

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**N**ext-generation  
wind turbines  
will be capable  
of producing  
electricity at  
a cost of  
\$0.025 per kWh  
at excellent  
wind sites.



NREL/PIX 02142

**The  
Atlantic  
Orient  
Corporation  
AOC 15/50**

power plants that total 12.6 megawatts (MW) in capacity. Another Zond turbine, the 750-kW Z-46, was chosen by Northern States Power Company of Minneapolis, Minnesota, for its two 100-MW planned wind power plants in southwestern Minnesota. In Iowa, several utilities are building wind power plants using Zond turbines with a combined capacity of about 200 MW. And in California, Zond is installing two power plants, together rated at 40 MW.

Another utility-scale turbine is the AWT-26, produced by Advanced Wind Turbines, Inc., of Redmond, Washington, and rated at 275 kW. Although suitable for U.S. utilities, these turbines have thus far found greater success in the international market. Many of these turbines were installed in India in 1996, and in China in 1997.

The AOC 15/50, produced by Atlantic Orient Corporation of Norwich, Vermont, is rated at 50 kW. In remote locations, this turbine can be used as part of a hybrid system for village power. For instance, in 1997, the Kotzebue Electric Association of Kotzebue, Alaska, installed three turbines to integrate with an existing diesel power plant. Also in 1997, the AOC 15/50 was installed in a number of states and in several other countries. Because it is sized ideally for powering villages, the AOC 15/50 will help meet the growing need for power in developing countries.

Even more advanced technology is on the way for the future. Currently, DOE is sponsoring a \$50-million project to develop the next generation of wind turbines, with 30% of the funds coming from private industry. These new, innovative, advanced turbines will be capable of producing electricity for \$0.025 per kWh at excellent wind sites.

## Project Partners

U.S. Department  
of Energy

Atlantic Orient  
Corporation

Advanced Wind  
Turbines, Inc.

Zond Energy  
Systems, Inc.

The Wind Turbine  
Company

### For More Information:

Wind Energy Program  
U.S. Department of Energy, EE-11  
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Web sites:  
U.S. Department of Energy Wind Energy  
Program at: <http://www.eren.doe.gov/wind>

The National Wind Technology Center at:  
<http://www.nrel.gov/wind>

Publications:  
*Wind Technology Development: Large  
and Small Turbines*  
[http://www.nrel.gov/wind/wind\\_turbines.html](http://www.nrel.gov/wind/wind_turbines.html)

*Wind Energy Program Overview, Fiscal Years  
1995 and 1996.* DOE/GO-10096-322,  
June 1997.

or contract:  
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